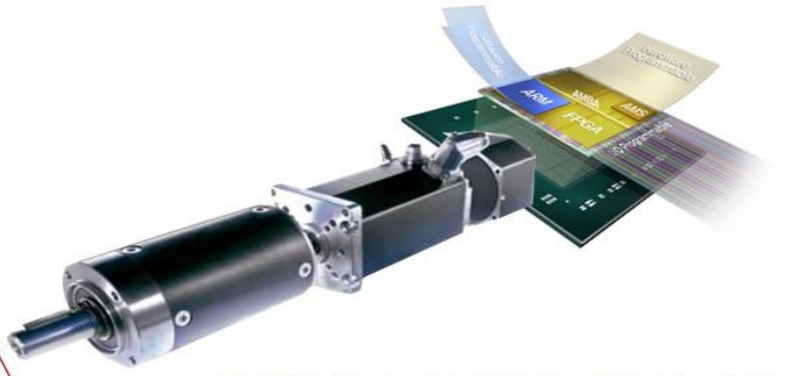
QDESYS
S/W for Embedded Systems

ZYNQ ARTIX 7 KINTEX 7 VIVADO



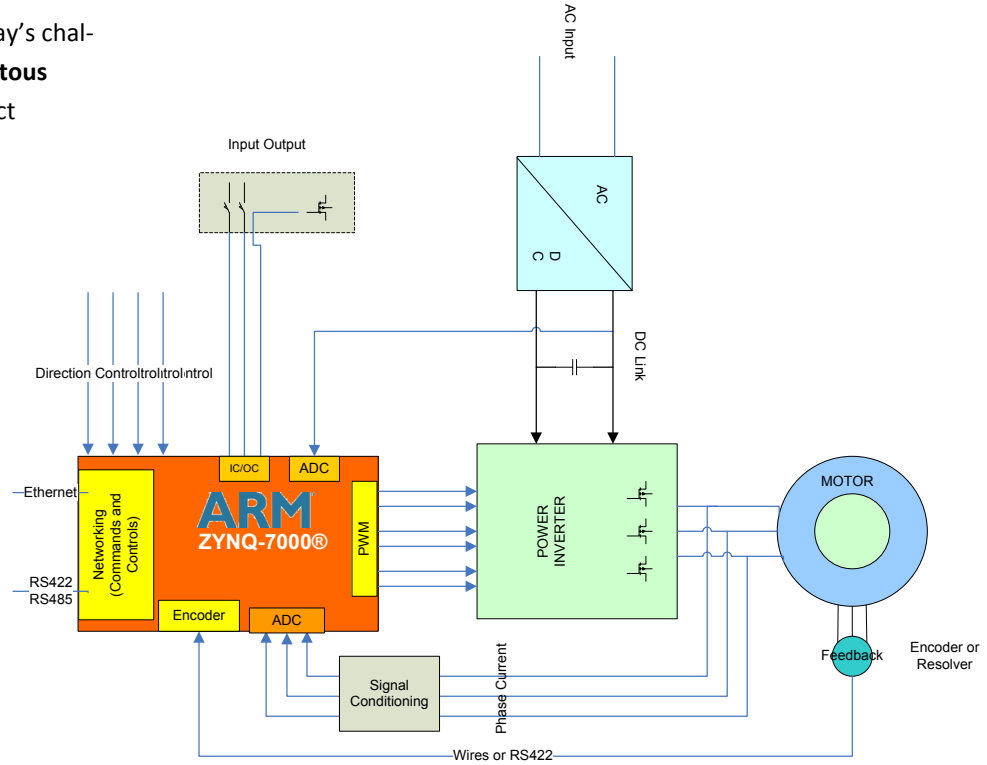
DRIVE, MOTOR CONTROL, 3-LEVEL INVERTERS SILICON CARBIDE SOLUTIONS

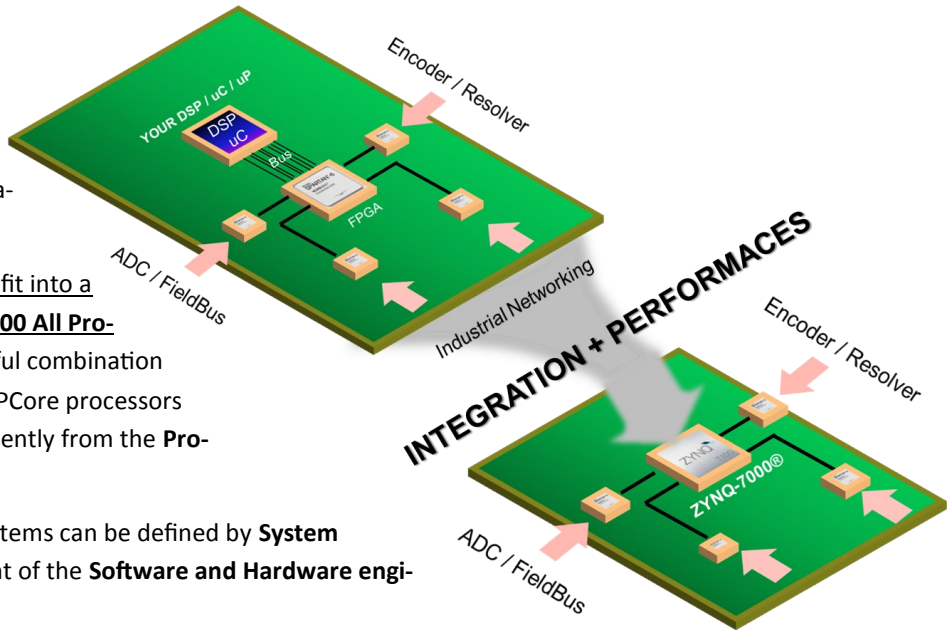
AMAZINGLY SMART

Zynq-7000 All Programmable SoC

MAXIMUM INTEGRATION HIGEST PERFOMANCES UNDISPUTABLE RELIABILITY FOR MOTOR CONTROL AND DRIVES

Platform is the right response to the today's challenges on power control systems. **Ubiquitous integration** is the driving force for product excellence in the robotic industry. **Ease of use** is the paradigm for customers and developer to get from the highest return in the minimum time. **Versatility** is the requirement to adapt to the always changing competitive requirements especially in power control applications. Highest **Reliability and Availability** in combination with **Safety Integrity** are the impelling demand from customers and operations that want to keep the highest unmanned operations and the lowest operational cost. **Performances** is the new **Industry-4.0** demand to collect, manage, process and deliver more sensed information and data to the factory supervisory systems for **optimization and tailoring** control efficiency for the factory floor electric motor applications.





<u>When all such requirements must fit into a **single chip** the answer is **ZYNQ-7000 All Programmable SoC.**</u> With the powerful combination of ARM® dual-core Cortex™-A9 MPCore processors system that can operate independently from the **Programmable Logic.**

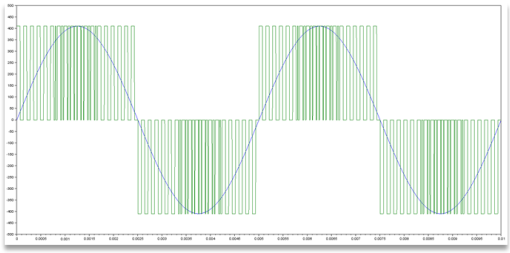
Drives, Motor Control, Robotic systems can be defined by **System Architects** to meet all requirement of the **Software and Hardware engineers** at once.

Xilinx provides **Electric Drives, Refrence Designs, Hardware in the loop, Matlab, Labview, C++, all the Industrial Networking Protocols** in a fluid, easy and comprehensive **solution sets.** You can maximize the change of success with the **ready to use full platforms for Electric Drives and Motor Control** available from Xilinx.

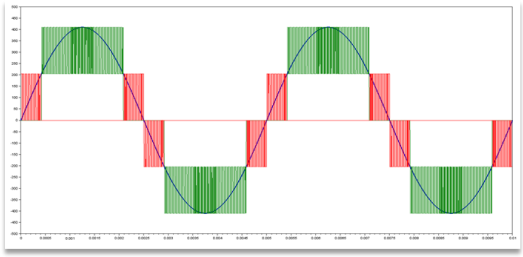
WHY 3-LEVEL INVERTER?

Multilevel power converters provide more than two levels of voltage to achieve smoother and less distorted ac-to-dc, dc-to-ac, and dc-to-dc power conversion.

2 Levels Inverter



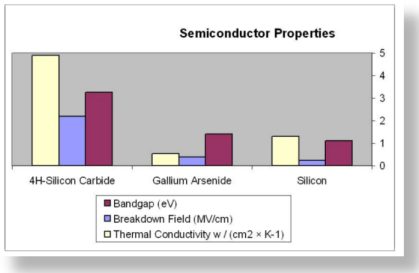
3 Levels Inverter



Compared to two level inverters, 3-Levels inverter have the following benefits:

- Smaller output voltage steps that mitigate motor issues due to long power cables between the inverter and the motor.
- Reduced surge voltages and rate of voltage rise at the motor terminals and motor shaft bearing currents.
- Cleaner output waveform providing an effective switching frequency twice that of the actual switching frequency.

WHY SILICON CARBIDE



Benefits

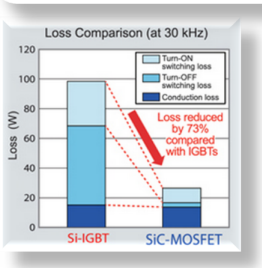
- Smaller inductors
- Smaller heat sinks
- Higher switching frequency than IGBT
- Smaller capacitors

Applications

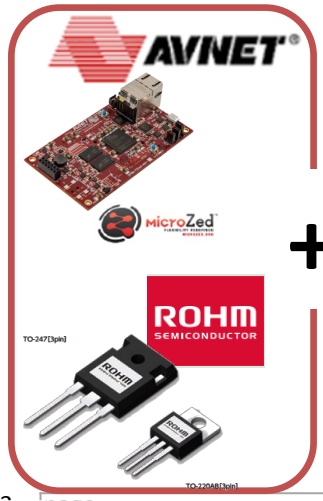
- Solar inverters
- Motor Drives
- DC-AC inverters
- Power Factor Correction

Technology

- Silicon Carbide (SiC) is a power transistor comprised of silicon (Si) and carbon (C).
- It sustains high voltages, with low series resistance, and low conduction losses.
- Its high band gap allows to switch higher voltages and currents at higher temperatures.



QDESYS 3-LEVEL **RPFM INVERTER** + AVNET **MICROZED** + ROHM **SiC**



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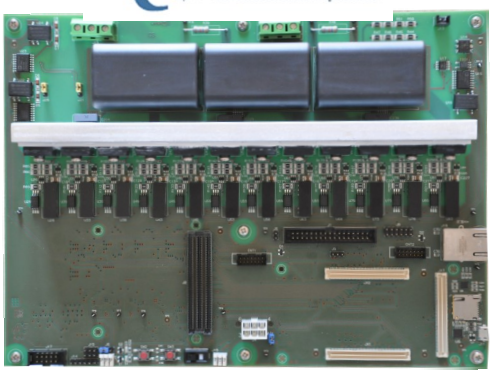

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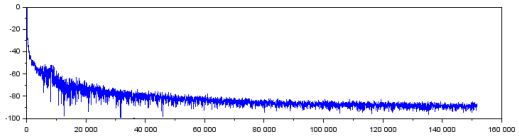
Very Low Distortion



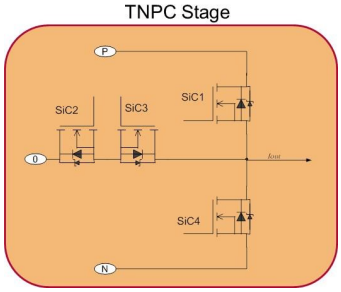
Zynq Laptop Size 10 KW 3-Level Inverter TNPC Silicon Carbide

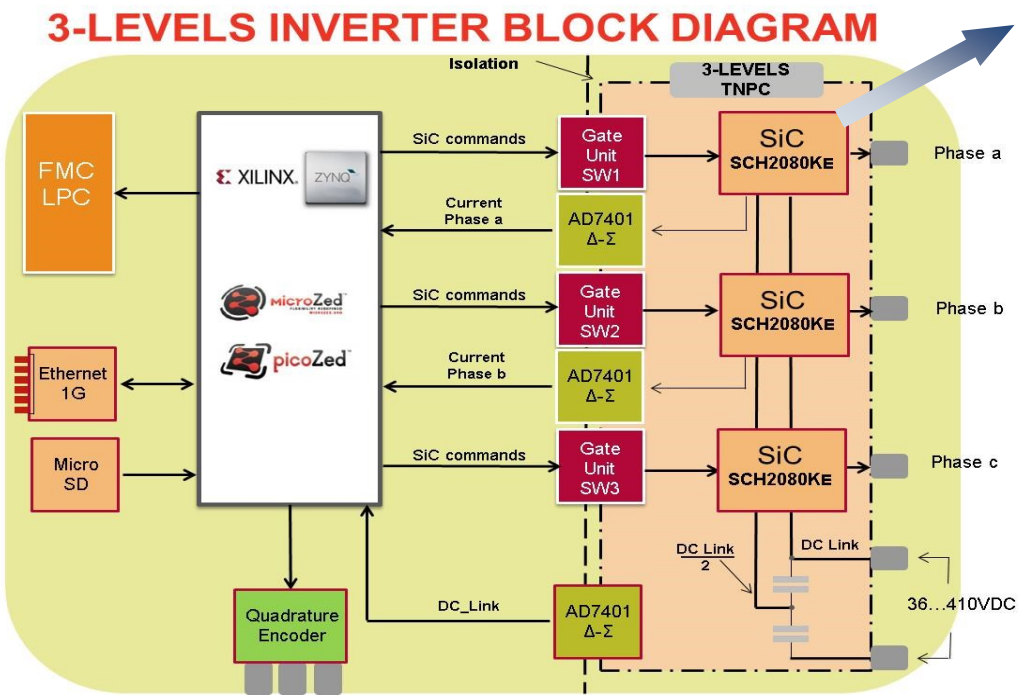
Multilevel power converters provide more than two levels of voltage to achieve smoother and less distorted ac-to-dc, dc-to-ac, and dc-to-dc power conversion.

This reference design implements a **laptop size 10KW 3-Level TNPC (or NPC2) Silicon Carbide Inverter**.

Silicon Carbide Mosfet are a new semiconductor type with higher operating temperature (175C), larger band-gap, and high voltage breakdown (1200V), very high switching capabilities that can deliver better performances compared to IGBTs for power inverters.

TNPC Stage





The three levels TNPC (3L TNPC; T-type Neutral Point Clamped) is a very efficient inverter configuration. The benefit of 3L TNPC is in its output voltage waveform while there are no restrictions to the switching scheme as in 3L NPC (especially in emergency shutdown).

The 3-levels inverter is implemented as carrier board supporting the **ZYNQ-7000® MicroZed and PicoZed SOM.** The configuration is ideal as product ready to use for all the markets.

12 SiCs are driven with the **RPFM Modulation** allowing **extremely low EMI and very low THD.**

The power modulator is capable to switch between **2 and 3 Levels on the fly.** The SiC high frequency capability is used in combination with the RPFM allowing very effective **DC balancing and small DC-Link capacitors.**

Up to **6 Temperature probes** can be connected to the carrier to monitor the inverter dissipation.

ZYNQ-7000® 1 Gigabit hardened Ethernet port is used for gateway and control connection toward the National instruments lab-studio graphical user interface, residing in a **PC. Lab-view, Matlab, SciLab, Microsoft dot net, C ++, and Visual Basic for applications** can also communicate by using this interface allowing investigation and further development.

Complete **FOC (Field Oriented Control)** and **SFOC (Sensorless Field Oriented Control)** is available in the reference design.

Availability

3-Level Inverter TNPC : info@qdesys.com

To download the evaluation: info@qdesys.com

Application Markets

Market	Benefit
Solar Market	Lower THD
Automotive Drives	Less Weight
Industrial Drives	Higher Efficiency

Zynq Laptop Size 10KW 3-Level Inverter TNPC Silicon Carbide Industrial Networking

The 3-levels inverter is implemented as carrier board supporting the **ZYNQ-7000® MicroZed and PicoZed SOM.** The configuration is ideal as product ready to use for all the markets.

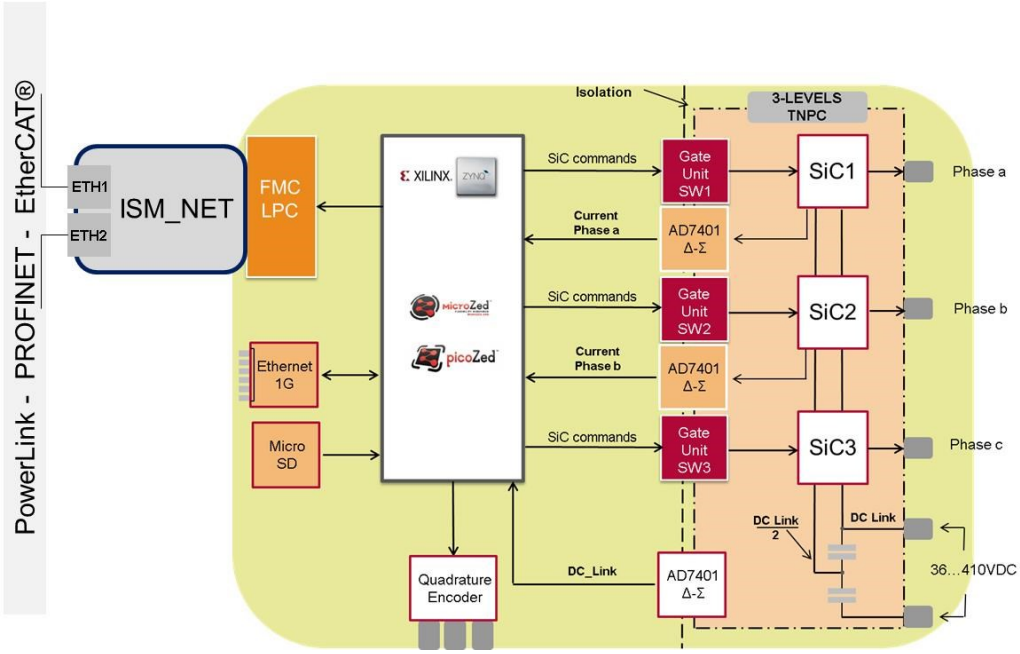
12 SiCs are driven with the **RPFM Modulation** allowing **extremely low EMI and very low THD.**

The power modulator is capable to switch between **2 and 3 Levels on the fly.** The SiC high frequency capability is used in combination with the RPFM allowing very effective **DC balancing and small DC-Link capacitors.**

The configuration implements an FMC connector to plug the AVNET ISM-NET daughter card.

With the ISM-NET it is possible to support **EtherCAT®, PowerLink, ProfiNET, Ethernet/IP,**and all the major industrial networking protocols.

3-LEVELS INVERTER + INDUSTRIAL NETWORK



For example the applications using the **IEC 61850 MMS/GOOSE server and client** can take advantage of ZYNQ-7000® support of **HSR/PRP,** for **Smart Grid Applications.**

This reference design is ideal as product ready to use for all the markets. gateway and control connection toward the National instruments lab-studio graphical user interface, residing in a **PC. Lab-view, Matlab, SciLab, Microsoft dot net, C ++, and Visual Basic for applications** can also communicate by using this interface allowing investigation and further development.

Avnet ISMNET FMC
(AES-FMC-ISMNET-G)

Availability

3-Level Inverter TNPC : info@qdesys.com

To download the evaluation: info@qdesys.com

Application Markets

Market	Benefit
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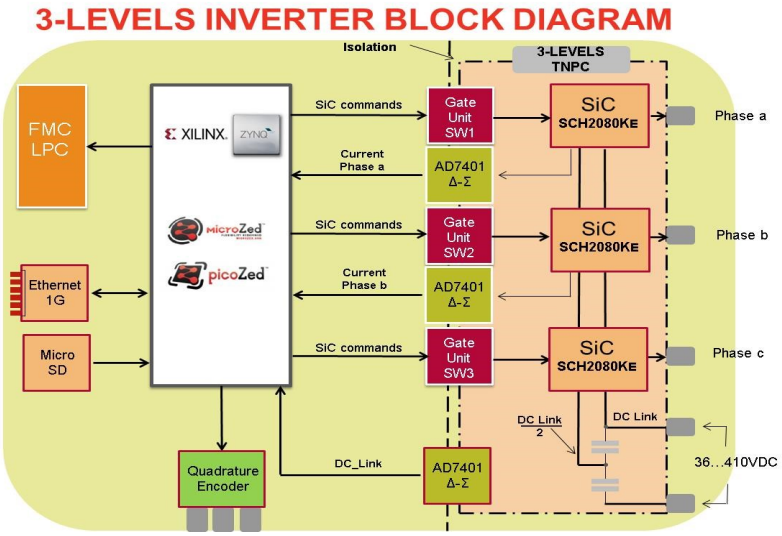
Zynq Laptop Size 10 KW 3-Level Inverter TNPC Silicon Carbide

Hardware Sliding Mode Sensorless Motor Drive

Direct Drive applications can largely benefit from SMC (Sliding mode control). SMC, is a nonlinear control method that alters the dynamics of a system by application of a discontinuous control signal that forces the controlled system to "slide" along specific trajectories of the its normal behavior. The feedback control law is a discontinuous function of time switching from one continuous structure to another based on the current position control variable state. In this design sliding mode control is used to implement a state observers for motor's speed and angle estimation having the ability to bring rapidly the error dynamics to zero in finite time. This observers has noise resilience similar to a Kalman filter but is much less sensitive to parameter and acquisition noise.

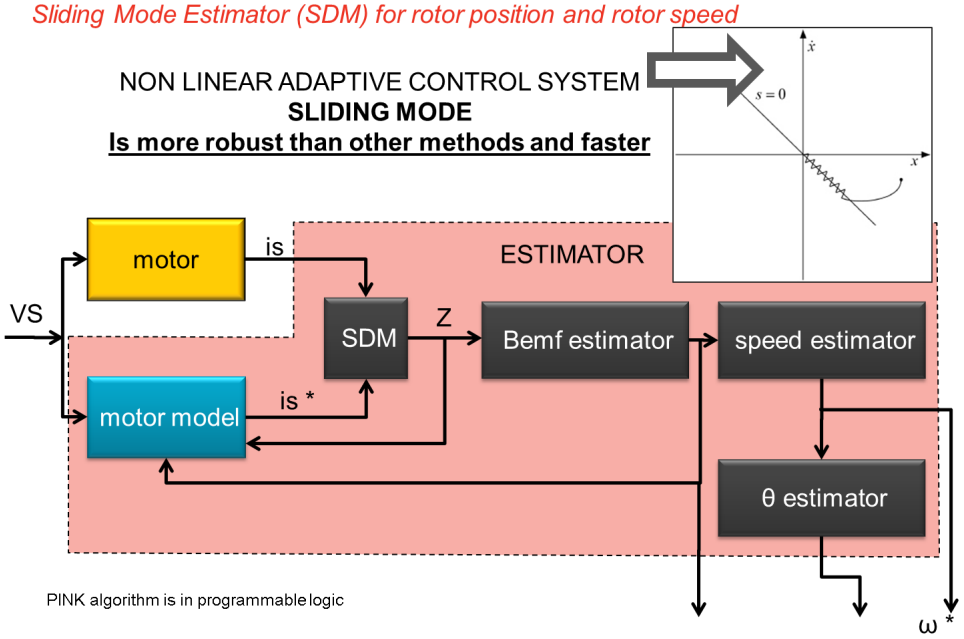
The sliding mode algorithm is implemented in programmable logic, targeting PMSM (Permanent Magnet Synchronous Motors).

In combination with 3-Level inverter this methodology is used to implement **SFOC (Sensorless Field Oriented Control).**



Sensorless Field Oriented Control

Sliding Mode Estimator (SDM) for rotor position and rotor speed



Performances of such Sensorless control are extremely good, making possible the **Sensorless control almost at 0 speed.**

The 3-levels inverter is implemented as carrier board supporting the **ZYNQ-7000® MicroZed and PicoZed SOM.** The configuration is ideal as product ready to use for all the markets.

12 SiCs are driven with the **RPFM Modulation** allowing **extremely low EMI and very low THD.**

The power modulator is capable to switch between **2 and 3 Levels on the fly.** The SiC high frequency capability is used in combination with the RPFM allowing very effective **DC balancing and small DC-Link capacitors.**

ZYNQ-7000® 1 Gigabit hardened Ethernet port is used for gateway and control connection toward the National instruments lab-studio graphical user interface, residing in a **PC. Lab-view, Matlab, SciLab, Microsoft dot net, C ++, and Visual Basic for applications** can also communicate by using this interface allowing investigation and further development.

Complete **SFOC (Sensorless Field Oriented Control)** is available in the reference design.

Availability

3-Level Inverter TNPC : info@qdesys.com

To download the evaluation: info@qdesys.com

Application Markets

Market	Benefit
Solar Market	Lower THD
Automotive Drives	Less Weight
Industrial Drives	Higher Efficiency

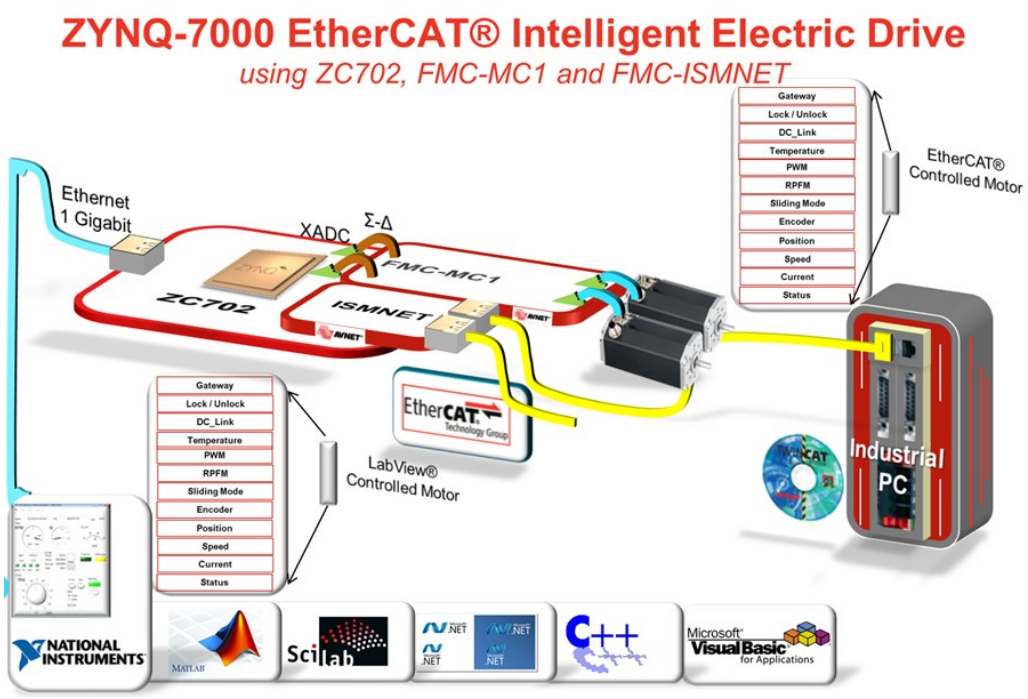
EtherCAT® Electric Drive with Hardware in the loop

The basic building blocks, for the Zynq-7000 intelligent Ether cat Drive, are.

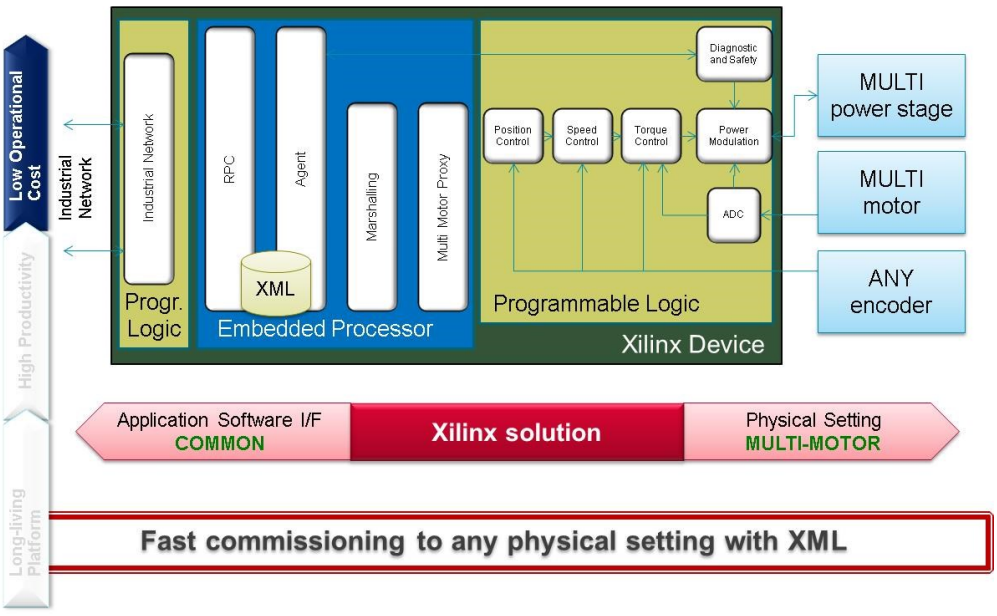
Zynq-7000 ZC702 carrier board. This board uses Zynq 7020 chip and is capable to host two FMC boards.

On the first FMC connector is plugged Avnet, FMC MC1, dual motors, 3 phases power stage board.

On the second FMC connector is plugged, Avnet ISMNET industrial networking FMC module adds key interfaces to support a wide range of industrial requirements.



From dual 1588 compatible 10/100 Ethernet PHYs, to CAN, RS232, and RS485, board networking interface, capable to support two fast Ethernet Physical Interfaces required by EtherCAT®.



Zynq ZC702 carrier board, is equipped with its own, 1 Gigabit hardened Ethernet port. This port, is the one used for gateway and control connection toward the National instruments lab-studio graphical user interface, residing in a **PC. Labview, Matlab, SciLab, Microsoft dot net, C ++, and Visual Basic for applications** can also communicate by using this interface.

A PC, or even better an industrial PC, hosts **Beckhoff TwinCat™. Twin cat** working as master, communicates directly on EtherCAT® transferring the data.

An arbiter, running on Zynq Cortex A9, is responsible to lock-down the control to ether cat or the gateway port. So, you can specify via the lock down, if the gateway port or ether cat owns of the selected motor channel. In this way the gateway and EtherCAT® , can read the information of each other, while only one, of the two, has full control of the specified motor channel.

Availability

EtherCAT_E_Drive: info@qdesys.com

ETHERCAT® IP from ETG: www.etg.org

To download the evaluation: info@qdesys.com